Experimental Researches regarding the State of the Mind in Vertigo.

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VERTIGO AS AN AID TO HYPNOTISM AND NARCOSIS.

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The State of Consciousness in Vertigo.—Very little has heretofore been ascertained respecting the condition of consciousness in vertigo. The greatest differences of opinion exist among writers on this point. Some affirm that in true vertigo there is no impairment of consciousness whatever; others are convinced that this can only be said of the minor degrees of the affection, and that in the severer varieties consciousness is always more or less deranged; while a third class of observers declare that the state of consciousness is invariably modified, be the dizziness pronounced or the reverse.

Multifarious Causation.—It is an undoubted fact that a very numerous and widely diversified class of derangements may give rise to what is known as vertigo, of which the true prototype is the group of phenomena produced by rapid rotation of the body around its longitudinal axes (rotary vertigo), as happens in dancing and the execution of certain acrobatic feats. Among the most common pathological causes of vertigo may be mentioned diseases of

the ear, impairment of vision, stomachic derangements, disorders of the cerebral circulation (anæmia, hyperæmia), and organic lesions of the central nervous system, more especially of the vermiform process of the cerebellum.

It is evident that causes so apparently diverse must have at least some point of agreement in order to produce practically the same effect. The most obvious element of agreement consists in this, that they are all capable of causing, directly or indirectly, some derangement of the cerebrum, and more especially of the cerebral cortex.

To what extent is cerebral function modified; or rather —to return to our first proposition—to what extent and in what manner is the field of consciousness altered in vertigo?

Before answering this question, let me state that what is called the "reaction time" affords valuable information as to the state of consciousness in its relations to the external world—"objective consciousness," as it has sometimes been called. As some who read this may have forgotten the precise nature of what is known among psychologists and physiologists as reaction time, a word or two of explanation will perhaps prove acceptable.

It is a matter of experimental demonstration, as well as the result of ordinary experience, that mental processes of all kinds require a certain amount of time for their accomplishment. Moreover, the length of time consumed is in the direct ratio of the complexity of the mental act. To illustrate this point, let us assume that an impression is made upon the retina of the eye, and that as soon as that impression is perceived the subject presses upon the key of an electrical apparatus and so records the interval of time between the peripheral excitation and the issuance of the same in the purposive act—the so-called "reaction time." It will be found, as a result of a series of observa-

tions of this kind conducted by the aid of appropriate apparatus, that the average time in different persons is from one tenth to two twelfths of a second.

If, however, instead of making a single impression of uniform character upon the retina, we make heterogenecus ones, as when red and blue are displayed in indefinite order, and the subject is instructed to press the key only when the color red appears, the interval of time is at least twice as long. This additional consumption of time is due to the fact that not only is the mind obliged to take cognizance of the impressions, but to distinguish and select from them. Hence, the use of the term "discrimination time," to designate this more complicated variety of psychical reaction. As a matter of course, it is possible to determine the reaction time to touch, hearing, and sight; but what is of most importance for present purposes is the fact that the duration of the reaction period is markedly influenced by a variety of agents which interfere with the spontaneous and co-ordinate action of the cerebro-spinal mechanism, and more especially of the brain. Thus the reaction time is shorter in health than in sickness, and it is longer after the ingestion of alcohol, ether, chloroform, or other agents which retard cerebral metabolism.

It follows, therefore, that by comparing the reaction time, after we have in some such way modified cerebral function, with the average normal reaction time, we shall, by a simple process of subtraction, be in a position to judge of the extent to which we have thus influenced the course of normal cerebration, particularly in its relation to the external world.

To appreciate the wide significance of this fact, it must be borne in mind that the central elaboration implied by what is termed reaction time is essentially composed of the perception of a sensation originating from without and the

formation thereupon of a definite volitional impulse. It is self-evident, therefore, that any change in the duration of the reaction time, contingent upon influences which act upon the cerebrum, means a corresponding modification of the mechanism of sensation and volition.

If to this we add the results of "discrimination time," we are moreover at once informed of the subject's power of distinguishing ("judging") between sensations.

The average values of the reaction time are variously stated by different observers; in my opinion, those given by Waller are as nearly correct as any: To touch, $\frac{14}{100}$ of a second; to sight, $\frac{18}{100}$ of a second; to hearing, $\frac{16}{100}$ of a second.

Various means of computing reaction time have been suggested and employed; that which consists in the use of an electro-magnet, having upon its armature a pen to record upon a revolving cylinder the instant when a visual, touch, or auditory stimulus is applied, and the signaling (pressing of a key) by the subject when the stimulus is felt, is, in my opinion, the best.

Realizing how much information may be obtained regarding the condition of the mind from the reaction time alone, I determined to utilize this principle for the purpose of obtaining precise data as to the psychical state in vertigo. To this end I had made for me a revolving chair, of which the principal elements of construction are these:

1. A high-backed wooden chair (Fig. 1, *a*) supported on a steel shaft, the point of which is pivoted. This shaft is held in place by a framework of iron bars (*b*) two feet and a half high.

2. At a distance of four feet from this chair is a steel shaft of the same height as the chair bottom, surmounted by a wheel, provided with a crank handle (*c*).

3. The steel shaft supporting the chair and that sur-

mounted by the crank wheel are provided with sprocket-wheels connected by a stout chain (*d*).

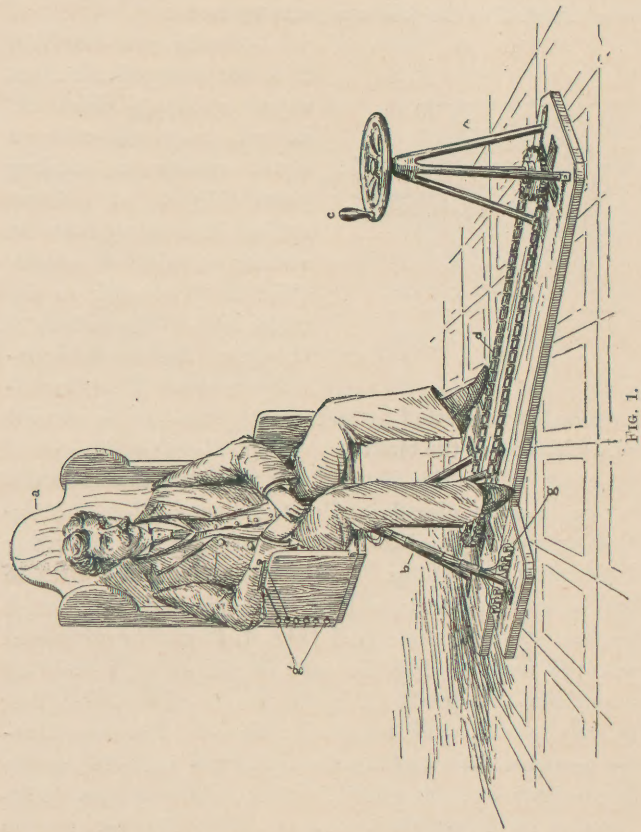

FIG. 1.

It is evident from the cut and foregoing description that turning the crank handle (*c*) is sufficient to rotate the chair (*a*). The gearing is, in fact, so arranged that one turn of the crank causes one revolution of the chair.

To enable the occupant of this chair to transmit the necessary signal to the recording apparatus (Fig. 3), I have resorted to the following arrangement:

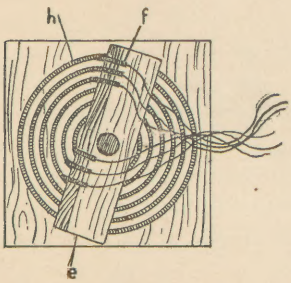

FIG. 2.

Upon the cross-bar (Fig. 2, *e*) are fastened six stout copper springs *f*, which are, in turn, connected with an equal number of binding posts (Fig. 1, *g*). These springs impinge against six circular tracks of copper (Fig. 2, *h*) secured on the under side of the bottom of the chair. Each track is carefully insulated from its fellows, and is connected by means of a gutta-percha-covered wire with one of the binding posts (*g'*, Fig. 1) on the side of the chair. From this disposition it is evident that the binding posts *g* are placed in direct communication with the binding posts *g'*. Now it is clear that the recording apparatus (Fig. 3) can be attached by insulated wires to the binding posts *g*; and in the same way the simple key for returning the signal (Fig. 1, *i*) may be connected with the posts *g*. For the sake of simplicity, a resonant sound, like that produced by the stroke upon a bell (Fig. 3), may be employed to give the signal. The extra binding posts are for attaching the apparatus required for the determination of the discrimination time in vertigo. This question of discrimination time I shall, however, reserve for a subsequent paper.

The Reaction Time and other Psychical Phenomena in Vertigo.—As a result of numerous observations with this apparatus I have found that the reaction time in vertigo is increased to three and even four tenths of a second, ac-

cording to the intensity of the vertigo. I may add that this intensity is directly dependent upon the rapidity of

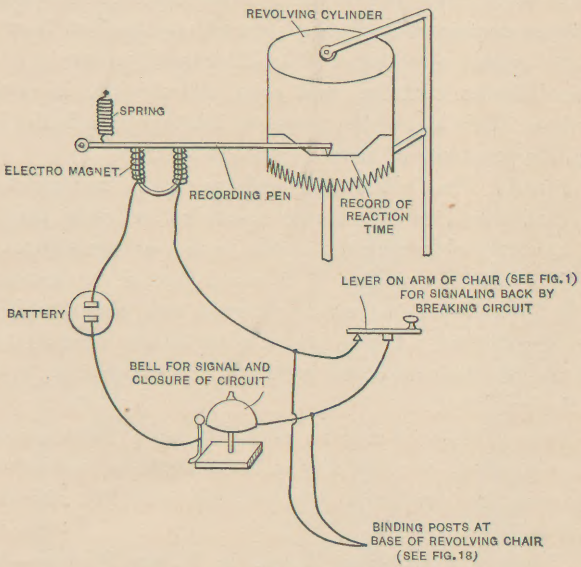

FIG. 3.

rotation of the subject. It follows, therefore, that in the determination of the reaction time we have a means of ascertaining with scientific accuracy the degree of intensity of the vertigo. It would be a manifest omission were I not to mention that something may also be learned regarding the condition of the mind during vertigo by the aid of self-observation, though only when the rotations are relatively slow, since introspection is extremely difficult, if not absolutely impossible, when the vertigo is severe.

In this way a decided diminution in the power of attention may be observed; the subject is quite unable to carry

on protracted thought so far as the analysis of external impressions is concerned; yet, in spite of all this, most remarkable to relate, the power of introspection, or subjective analysis, remains but slightly if at all impaired, at least in minor degrees of vertigo. The last-named power is, however, likewise curtailed and even entirely lost in severe vertigo. This loss of the power of introspection is the immediate precursor of absolute unconsciousness.

Finally, the ability to perform tasks necessitating rhythmical and delicate motor co-ordination, as in playing upon a musical instrument, is lost in the severer degrees of vertigo. It is true that it is often possible to execute a series of automatic or semi-automatic acts, as exemplified in a simple scale; but to play a composition necessitating a conscious demand of the memory, or to improvise, is out of the question.

In conclusion, it may be said that while there is a certain obtunding of sensibility in the severer degrees of vertigo, complete analgesia appears only with the advent of total unconsciousness.

Physical Phenomena Present in Rotary Vertigo.—But the reaction time is by no means the only phenomenon of which we are able to take cognizance by the aid of the rotary chair. In the first place, since the vertigo persists for a short time after cessation of rotation, it is possible to make some observations as to the subject's physical condition. Acting upon this principle, I was able to ascertain that in vertigo of moderate intensity the pulse, while somewhat increased in rapidity, is diminished in fullness. I have also observed a diminution in the rapidity of respiration; but this is not a constant phenomenon.

Again, when the vertigo is severe, the inhibitory effect of the brain upon the spinal cord is diminished to such a degree that reflex action, and especially the patellar tendon

reflex, is decidedly exaggerated. There is likewise diminished vigor of voluntary muscular contraction, as shown by the dynamometer.

Finally, in severe vertigo there is apt to be facial pallor

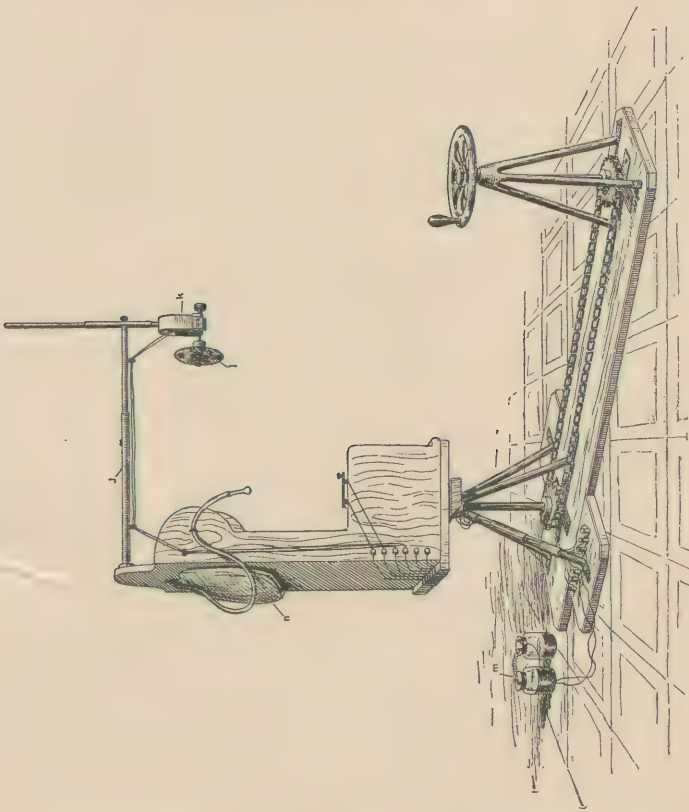

FIG. 4.

accompanied by a marked dilatation of the pupils. Nausea, too, sometimes occurs, especially when the eyes are fixed upon surrounding objects. The last-named symptom may

usually be avoided by the previous administration of the bromides in large doses and by requiring the subject to keep his eyes shut; or, when this is not done, darkening the room so that surrounding objects are rendered invisible. I may add that when the object looked at revolves with the chair nausea is much less readily produced.

Artificially Induced Vertigo as an Aid to Hypnotism.—After ascertaining the facts previously noted the thought occurred to me that vertigo might prove of service as a means of facilitating the induction of the hypnotic state.

To test the feasibility of the idea, I caused to be attached to the back of the revolving chair the bracket *j* (Fig. 4), consisting of a horizontal and vertical arm, the latter supporting at its lower extremity the small electric motor, *k*, which is used to revolve a series of mirrors, arranged on the disk *l*, shown also in Diagram 4. As both the horizontal and vertical arms of the bracket may be lengthened or shortened within reasonable limits, it is possible, when the occupant of the chair fixes his gaze upon the mirrors, to obtain a certain amount of ocular convergence, whereby the occurrence of hypnosis is somewhat facilitated. Adequate current for the motor is afforded by a few cells, *m*, which transmit their energy through the circular railway, springs, and insulated wires previously described.

Repeated trials have convinced me that it is indeed possible to facilitate the induction of the hypnotic state by this apparatus; but I have also learned that the vertigo should be of moderate degree, since, when the dizziness is too intense, the subjective sensations engendered by it tend to inordinately diminish the subject's power of attention.

The Physiological Effects of Nitrous Oxide are Accelerated and Enhanced by Vertigo.—If a person while in a condition of vertigo is allowed to inhale nitrous oxide, it

will be found that much less of the gas is required to produce the characteristic phenomena than when the agent is administered in the ordinary way.

This is well shown by the following observation:

Mr. N. E. has long been addicted to the periodic abuse of alcohol. When recovering from one of his "sprees" the depression consequent upon the abrupt withdrawal of the stimulant is much relieved by inhalations of nitrous oxide at intervals of ten or fifteen minutes. To dispel the depression and produce slight exhilaration, from three to four gallons of the gas are necessary—a quantity considerably in excess of what would be required to evoke the same phenomena in persons unaccustomed to alcoholic abuses. Yet, when N. E. seats himself in the revolving chair, and while rapidly rotated inhales the gas from the rubber receptacle (*n*), but a gallon and a half of the nitrous oxide are required to produce a feeling of *bien-être.*

The mode of attaching the rubber receptacle and tube to the chair is sufficiently shown in Fig. 4.

Mrs. J. L. V., who has been under my care for functional nervous trouble, states that she has had several teeth extracted under nitrous oxide, but says it has always affected her disagreeably. During the period of anæsthesia she is subject to hallucinations of a more or less disagreeable character, and even after the recovery of consciousness she invariably drifts into a lacrymose condition lasting several hours and bearing a close relation to hysteria. She has, moreover, been informed by the dentist that the amount of gas required to produce insensibility is considerably above the average. On one occasion the inhalation of the gas was followed by the usual hysterical symptoms, albeit much abbreviated, and these were in turn succeeded by morbid somnolence lasting half a day.

Such cases, though not numerous, are nevertheless oc-

casionally met with. From a neurophysiological standpoint they are certainly interesting. Being impressed by the paradoxical nature of the phenomena, I one day asked this lady to sit in the revolving chair and inhale the nitrous oxide gas while subjected to from thirty to forty rotations a minute. To this she readily consented, as well as to the clamping of her nostrils to prevent the entrance of air.

In an astonishingly short time, and after the inhalation of but a moderate amount of gas, the tube fell from her mouth and she was unconscious. She would indeed have fallen to the floor had I not forestalled the possibility of such an occurrence by encircling her waist with a broad belt secured to the back of the chair.

On regaining consciousness she declared that she had had no hallucinations whatever, and that the entire experience had been without disagreeable incident. What subsequently impressed her as most remarkable, however, was the absence of all hysterical manifestations or somnolence. These she had grown to regard as necessary after-evils.

It would be easy to multiply cases showing how vertigo facilitates the occurrence and enhances the physiological effects of nitrous oxide as well as ether. This would involve, however, but a needless repetition, and I shall therefore content myself with briefly summarizing the salient results of my researches.

Summary.—1. In vertigo, however slight, consciousness is always impaired.

2. This impairment increases in the direct ratio of the intensity of the vertigo.

3. Though the clinical causes of vertigo are manifold, they have at least this in common, that they one and all are capable of interfering, either directly or indirectly (reflex-

ly) with cortical function, with consequent impairment of consciousness. To regard vertigo as essentially a cortical derangement, of either direct or indirect origin, accords with the experimental data and is clinically explanatory.

4. The condition of psychical instability and sluggishness engendered by vertigo favors the occurrence of hypnosis.

5. A person in a state of vertigo is thereby rendered unusually susceptible to the influence of nitrous oxide, ether, and other agents of like character; but, if the anæsthetics are first inhaled in moderate quantity (without inducing unconsciousness), it will be found that when an attempt is made to induce vertigo the latter is diminished or entirely prevented. The significance of this last fact from a neurophysiological standpoint is apparent.

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